

Europäisches Patentamt

European Patent Office

Office européen des brevets



(11) EP 0 902 385 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.03.1999 Bulletin 1999/11

(51) Int. Cl.⁶: G06K 1/12

(21) Application number: 98115925.4

(22) Date of filing: 24.08.1998

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

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(30) Priority: 15.09.1997 US 929852

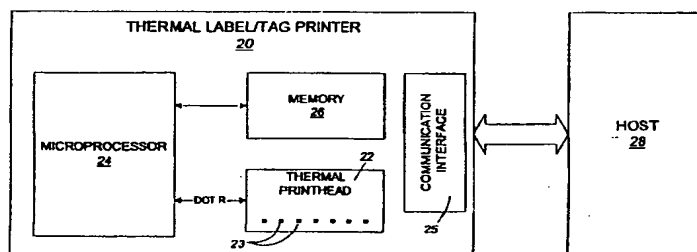
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(54) Early thermal printhead failure prediction system

(57) A thermal printer early printhead failure prediction system detects possible printhead an/or printing element failure in response to the sensed resistance of the printhead or an individual element thereof. A microprocessor of the printer monitors the resistive trends of

the printing elements. A warning is generated when a characteristic of the resistive trend exceeds a predetermined boundary.

FIG. 1



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Description**TECHNICAL FIELD**

[0001] The present invention is directed to a thermal printer for printing tags and/or labels and more particularly to such a printer and method for predicting thermal printhead failure.

CROSS-REFERENCE TO RELATED APPLICATIONS

[0002] Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0003] Not applicable.

BACKGROUND OF THE INVENTION

[0004] Known thermal label/tag printers include thermal printheads containing individual printing elements 23. When a printing element fails, it may result in a discontinuity in the printing. Prior thermal label printers have used data dot shift routines to shift data around a failed printing element so that the failed printing element is aligned with "zero" print data. This feature extends the useful life of a thermal printhead. However, such routines do not provide any warning as to when a printing element is failing.

BRIEF SUMMARY OF THE INVENTION

[0005] The early thermal printhead failure prediction system of the present invention is directed to overcome the limitations of the prior data dot shift routines described above. The early thermal printhead failure prediction system of the present invention monitors the resistive trends of the individual printing elements 23 of a thermal printhead to provide a warning indication when the resistive trends deviate beyond predetermined limits.

[0006] More particularly, in accordance with the present invention, a microprocessor monitors the resistive trends of the printing elements 23 of the thermal printhead. A read/write memory may be used to store previous resistive values of the individual printing elements 23 for use in determining the resistive trend. The microprocessor compares one or more characteristics of the resistive trend to predict whether an individual printing element is failing. If the microprocessor determines that an individual printing element may be failing, a warning to that effect is generated.

[0007] When the microprocessor of a thermal label/tag printer executes such a printhead failure prediction routine, maintenance may be scheduled before the thermal printhead fails and/or data dot shift routines become ineffective.

[0008] These and other advantages and novel features of the present invention, as well as details of an illustrated embodiment thereof, will be more fully understood from the following description and drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING**[0009]**

Fig. 1 is a block diagram of a thermal label/tag printer of the present invention in communication with a host; and

Fig. 2 is a flow chart illustrating a thermal printhead failure prediction routine of the thermal label/tag printer of Fig. 1.

DETAILED DESCRIPTION OF THE INVENTION

[0010] A thermal label/tag printer 20 in accordance with the present invention, as shown in Fig. 1, includes a thermal printhead 22 for printing barcode and/or alphanumeric data on a web of record members such as tags and labels. A microprocessor 24 controls the operation of the thermal printhead 22, which includes a plurality of printing elements 23, alternately referred to as dot elements. Specifically, the microprocessor 24 controls the printhead 22 to print data received from the host 28 and/or other input devices, not shown, such as a keyboard, barcode scanner, etc., in accordance with software stored in the memory 26. The memory 26 may include ROM and/or RAM, and/or a flash type memory, etc. The microprocessor 24 also monitors the condition of the thermal printhead to determine whether one or more printing elements 23 are likely to fail soon as discussed in detail below.

[0011] The thermal label/tag printer 20 communicates with the host computer 28 via a communication interface 25 which may take the form of a hard-wired interface, such as a RS 232 interface, or a wireless interface, such as a radio frequency (RF) or infrared (IR) interface.

[0012] The microprocessor 24 executes the thermal printhead failure prediction routine, depicted in Fig. 2, to predict whether an individual printing element of the thermal printhead is failing. The routine is preferably executed to monitor each of the printing elements 23 of the printhead 22 by looping through the routine until all of the printing elements 23 are checked. Alternatively, it may be executed a single time to predict whether one printing element is failing, or it may be executed several times to test a subset of the printing elements 23 of the thermal printhead 22.

[0013] The first time that the routine is executed, the first printing element position is loaded prior to execution of the routine as depicted in Fig. 2. Alternately, if it is desired to only test a single printing element, that element position is loaded prior to execution. If it is desired to test a subset of the printing elements 23, the position

of the first printing element of the subset is loaded prior to execution. The microprocessor 24 then begins the failure prediction routine by evaluating the loaded printing element or dot element of the thermal printhead 22. Specifically, the microprocessor 24 determines the current resistance value of the printing element at block 100 and stores this value for later use. At block 102, the microprocessor 24 determines whether the resistance of the printing element indicates that it has failed. If the microprocessor 24 determines at block 102 that the printing element has not yet failed, the microprocessor 24 proceeds to block 104 where it compares a resistance value, or values, previously stored for that printing element to the current resistance that was found at block 100 to determine a resistive trend. If the microprocessor 24 determines at block 106 that the resistive trend of the printing element is increasing, the microprocessor 24 proceeds to block 108 to determine whether a characteristic of the increasing resistive trend has exceeded predetermined boundaries. This determination may be made by comparing the curve defined by the resistive trend for the printing element to a predetermined, previously stored curve to determine whether the printing element is approaching failure. The difference between the curve defined by the resistive trend and a predetermined curve can also be examined to determine whether the printing element is approaching failure. For example, the average value and/or the maximum value and/or the minimum value of the difference between the curves may be compared to predetermined values to determine whether the printing element is approaching failure. Alternatively, this determination may be made by comparing the slope or rate of change of the resistive trend for the printing element to a predetermined slope or rate of change. The current resistance value of the printing element may also be used as the characteristic of the trend where the resistance is compared to a reference value to determine whether it is greater than the reference indicating approaching failure of the element.

[0014] If a characteristic of the resistive trend exceeds the predetermined boundaries as determined at block 108, the microprocessor 24 predicts that the printing element is failing and proceeds to block 110. At block 110 the microprocessor 24 stores in memory the position of the printing element predicted to fail. The microprocessor 24 then proceeds to block 124 to generate a warning message that preferably includes the identity of the printing element approaching failure and/or its position. The warning message may be sent to a host computer 28 via a communication interface 25 in the thermal label/tag printer 20. Alternatively, a warning indication may be directly displayed to the user of the thermal label/tag printer 20. For example, a message may be displayed on a display of the thermal label/tag printer 20 or a warning LED on the thermal label/tag printer 20 may be illuminated. The next printing element position to be evaluated is then loaded by the microprocessor 24

in block 114. This allows all printing elements 23 of the thermal printhead 22 to be monitored when the routine is executed in a loop. If the routine is executing in a loop, the microprocessor 24 returns to block 100 to continue testing the remainder of the printing elements 23 of the thermal printhead 22.

[0015] If the microprocessor 24 determines in block 108 that the resistive trend does not exceed predetermined boundaries, the next printing element is loaded at block 114. If the routine is executing in a loop, the microprocessor 24 then returns to block 100.

[0016] If the microprocessor 24 determines in block 106 that the resistive trend is not increasing, the microprocessor 24 proceeds to block 116 where it evaluates whether the resistive trend is decreasing. If the resistive trend is not decreasing, the next printing element is loaded at block 114. If the routine is executing in a loop, the microprocessor 24 then returns to block 100.

[0017] If, however, the microprocessor 24 determines at block 116 that the resistive trend is decreasing, the microprocessor 24 then determines at block 118 whether a characteristic of the decreasing resistive trend has exceeded predetermined boundaries in a manner similar to that described with reference to block 108. If a characteristic of the resistive trend exceeds predetermined boundaries, the microprocessor 24 proceeds to block 110 and stores the position of the predicted failing printing element in memory 26. At block 110, the microprocessor 24 also stores selected characteristics of the resistive trend. The microprocessor 24 then proceeds to block 124 to generate a warning message indicating the printing element approaching failure and/or its position. The warning message may be sent to a host computer 28 via a communication interface 25 and/or a warning indication, such as a message on a display screen of the thermal label/tag printer 20 or an illuminated LED on the thermal label/tag printer 20, may be displayed. The next printing element position is then loaded by the microprocessor 24 at block 114. If the routine is executing in a loop, the microprocessor 24 returns to block 100 to continue testing the remainder of the printing elements 23 of the thermal printhead 22.

[0018] If the microprocessor 24 determines at block 118 that the downward resistive trend has not exceeded predefined boundaries, the microprocessor 24 proceeds from block 118 to block 114 and loads the position of the next printing element to be evaluated at block 114, thereafter returning to block 100 if the routine is executing in a loop.

[0019] If, at block 102, the microprocessor 24 determines that the loaded printing element has failed, the microprocessor 24 proceeds to block 120 where it increments a variable or register to indicate that it has detected another failed printing element. This variable or register may be stored in memory 26. The microprocessor 24 then proceeds to block 122 where it evaluates whether three or more failed printing elements 23 have been detected yet by checking the variable or register

recording the number of failed printing elements 23. If three or more printing elements 23 in the thermal printhead 22 have failed, the microprocessor 24 proceeds to block 110 where the position of the failed printing element is stored in memory 26 along with an indication that the element has failed. The microprocessor 24 then proceeds to block 124 where a warning message is generated indicating that the thermal printhead 22 has failed. The warning message may be sent to a host computer 28 via a communication interface 25 and/or a warning indication may be directly displayed to the user of the thermal label/tag printer 20. The microprocessor 24 then loads the position of the next printing element to be evaluated at block 114. If the routine is executing in a loop, the microprocessor 24 returns thereafter to block 100.

[0020] In practice, it is known that data to be printed may be shifted around one or two failed printing elements 23 and still be printed with acceptable results. As a result, if fewer than three failed printing elements 23 are detected at block 122, the microprocessor 24 at block 126 performs a known data dot shift routine to shift data to be printed around the failed printing element. Thereafter the microprocessor 24 proceeds from block 126 to block 114 where the microprocessor 24 loads the position of the next printing element to be evaluated. If the routine is executing in a loop, the microprocessor 24 returns to block 100.

[0021] Many modifications and variations of the present invention are possible in light of the above teachings. Thus, it is to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as described hereinabove.

[0022] What is claimed and desired to be secured by Letters Patent is:

Claims

1. In a barcode printer, a system to predict thermal printhead failure comprising:

a thermal printhead including a plurality of printing elements, each printing element having an associated resistance value; and a processor for sampling over time a plurality of resistance values for at least one of said printing elements and for comparing each sampled resistance value to its immediately preceding sampled resistance value for that printing element to determine a trend of the resistance of at least one of said printing elements, said processor generating a warning for indicating when a characteristic of the resistive trend deviates beyond a predetermined boundary.

2. The barcode printer as defined in claim 1, wherein said characteristic of said resistive trend exceeds a predetermined boundary when the rate of increase

in the resistive trend exceeds a predetermined value.

3. The barcode printer as defined in claim 1, wherein said characteristic of said resistive trend exceeds a predetermined boundary when the rate of decrease in the resistive trend exceeds a predetermined value.
4. In a printer for printing on a web of record members, a system for detecting thermal printhead failure comprising:

a thermal printhead including a plurality of printing elements each having an associated resistance;

a processor for sampling the resistance of a plurality of said printing elements over time to determine an associated resistive trend for each of said plurality of printing elements by comparing each resistance sampled for a given printing element to its immediately preceding sampled resistance for said given printing element, said processor determining whether the resistive trend of each printing element exceeds a predetermined limit; and a read/write memory for storing the position of a printing element determined to have a resistive trend that exceeds a predetermined limit.

5. The printer for printing on a web of record members as defined in claim 4, wherein said resistive trend exceeds said predetermined limit when the rate of increase in the resistive trend exceeds a predetermined value.
6. The printer for printing on a web of record members as defined in claim 4, wherein said resistive trend exceeds said predetermined limit when the rate of decrease in the resistive trend exceeds a predetermined value.
7. The printer for printing on a web of record members as defined in claim 4, wherein said microprocessor determines whether said resistive trend of one of said printing elements exceeds said predetermined limit by comparing said resistive trend of one of said printing elements to a predetermined curve.
8. A method of monitoring a thermal printer having a thermal printhead comprising a plurality of printing elements, a processing means, and a memory for storing data, comprising:

sampling over time a plurality of resistance values for at least one of said printing elements; storing said sampled resistance values; comparing each of said resistance values sam-

pled for a print element to its immediately preceding sampled resistance value for the print element to determine a trend;

comparing a characteristic of said resistance trend to a reference; 5

storing the printing element position in said memory when said characteristic of said resistance trend exceeds said reference; and

generating a warning when said characteristic of said resistance trend exceeds said reference. 10

9. The method of monitoring a thermal printer as recited in claim 8 including the step of sending said warning to a host computer. 15

10. A method of monitoring a label printer having a thermal printhead including a plurality of printing elements, a processing means, and a memory comprising: 20

sampling over time a plurality of resistance values for at least one of said printing elements;

storing said sampled resistance values;

comparing each of said resistance values sampled 25

for a print element to its immediately preceding sampled resistance value for the print element to determine a trend;

determining if said resistance trend is increasing or decreasing; 30

comparing a characteristic of said resistance trend to a first reference when said resistance trend is increasing to determine if an upper limit is exceeded;

comparing a characteristic of said resistance 35

trend to a second reference when said resistance trend is decreasing to determine if said characteristic falls below a lower limit; and

generating a warning when either said upper limit is exceeded by said characteristic or said 40
characteristic is below said lower limit.

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FIG. 1

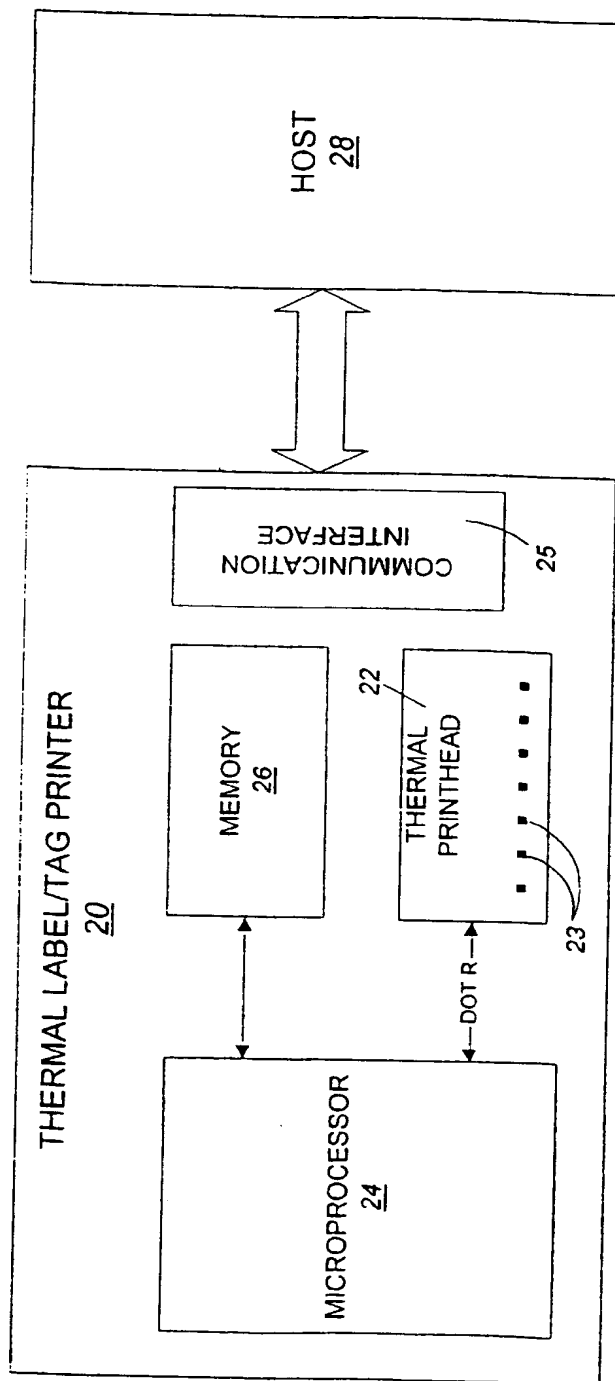
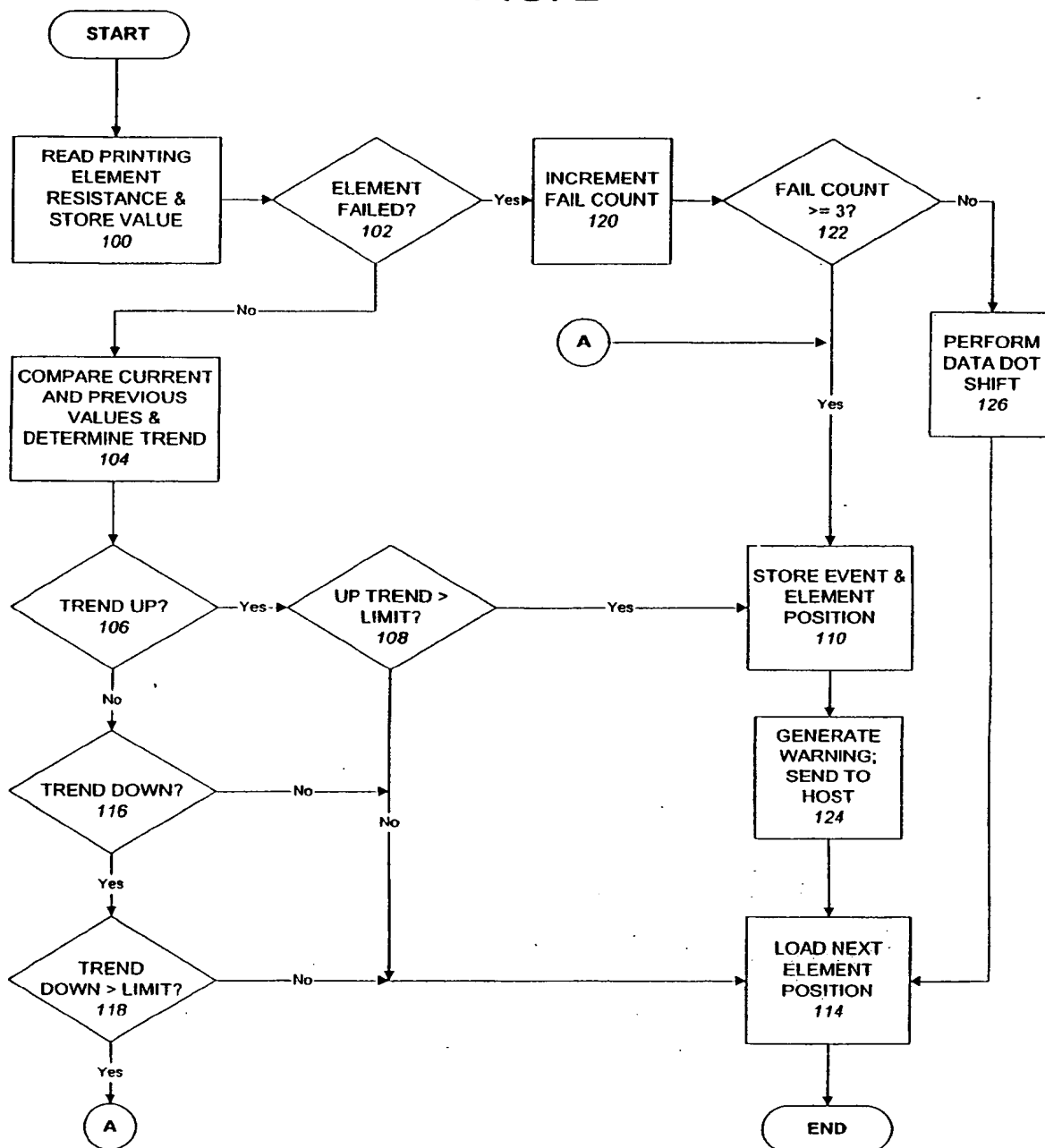
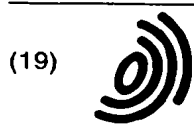


FIG. 2



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(11)

EP 0 902 385 A3

(12)

EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
09.01.2002 Bulletin 2002/02

(51) Int Cl.7: **G06K 1/12**, G06K 15/02,
B41J 2/35

(43) Date of publication A2:
17.03.1999 Bulletin 1999/11

(21) Application number: **98115925.4**

(22) Date of filing: **24.08.1998**

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(30) Priority: **15.09.1997 US 929852**

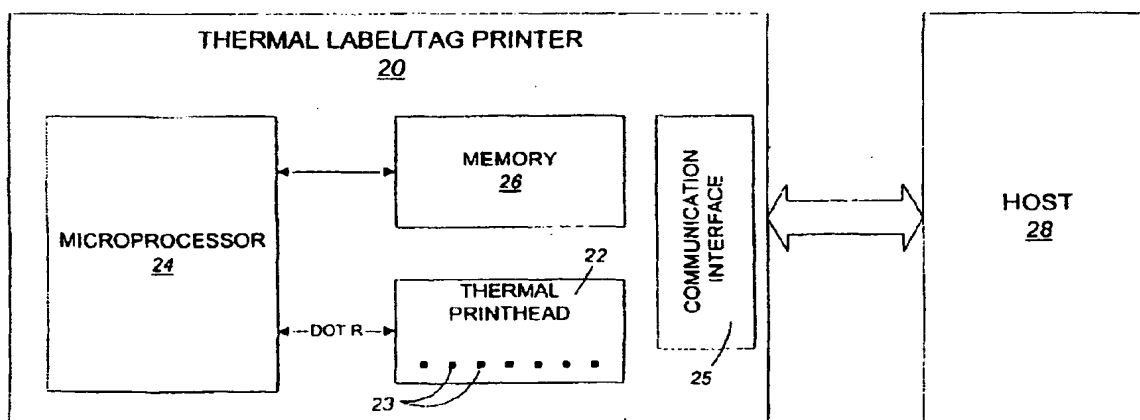
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(57) A thermal printer early printhead failure prediction system detects possible printhead an/or printing element failure in response to the sensed resistance of the printhead or an individual element thereof. A micro-

processor of the printer monitors the resistive trends of the printing elements. A warning is generated when a characteristic of the resistive trend exceeds a predetermined boundary.

FIG. 1





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EUROPEAN SEARCH REPORT

Application Number
EP 98 11 5925

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 174 751 A (NCR CANADA) 19 March 1986 (1986-03-19) * abstract * * page 8, line 14 - page 10, line 7; figure 3 *	1,4,8,10	G06K1/12 G06K15/02 B41J2/35
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			G06K B41J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 19 November 2001	Examiner Degraeve, A
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons & : member of the same patent family, corresponding document</p>			

EPO FORM 15/03-03-82 (P04/G01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 98 11 5925

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19-11-2001

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